REMARKS / ARGUMENTS

The specification has been amended to correct the informalities cited by the examiner.

Claim 1 was objected to due to an informality, and it has been duly corrected.

Claim 12 was rejected under 35 USC 112, second paragraph. The necessary antecedent basis has been provided by amendment of claim 12. Accordingly the rejection is deemed to have been overcome.

Claims 1, 3, 4, 6, 14, 21, and 25 have been rejected under 35 USC 102(b) as being anticipated by Nichani et al. (5,673,334). To sustain a rejection under 35 USC 102(b), the Examiner must show that each element of the claim is taught by Nichani. To overcome such a rejection, Applicant must show that at least one element is NOT taught by Nichani.

For example, the second element of claim 1 is clearly not taught by Nichani. To make the difference even more clear, claim 1 has been amended to explicitly state that "the region of interest in its entirety" is divided "into a plurality of sub-regions". By contrast, at col. 7, lines 36-46, Nichani teaches that:

> A window 84 in which each of the patterns lies
> is stored along with the patterns 82 in the envelope

data structure 80. The windows stored at train time
provide respective **limited** areas of search for each of
the coarse alignment patterns. The trained windows
to be searched within the field of view, **limit the**
extent of area searched and expedite the process of
locating the coarse alignment patterns. These coarse
alignment patterns areas of search should be
selected to be **big enough** to accommodate the
uncertain orientation of the package at run time.
(emphasis added)

Thus, Nichani teaches a method of creating windows that does NOT cover
the entire region of interest. By contrast, Applicant's windows are created in a
way that ensures that the entire region of interest is covered by sub-regions.
(Eg. see Fig. 3) For further example, on page 6, lines 6-9, "if a sub-region cannot
be located by the search tool due to, for example, spatial distortion, the sub-
region can be further sub-divided into smaller sub-regions in an effort to find a
sub-region size which could be located by the search tool". Thus, the windows of
Nichani are NOT the same as the sub-regions of Applicants' invention.

Moreover, Applicants' claim 1, second element, requires that each sub-
region should be "**small** enough such a that a conventional inspecting method
can reliably inspect each of the sub-regions". By contrast, Nichani teaches
"These coarse alignment patterns areas of search should be selected to be **big**
enough to accommodate the uncertain orientation of the package at run time."
Thus, Nichani teaches away from **reducing** the size of sub-regions to enhance

the likelihood that a search algorithm will work, instead teaching that a window much be **enlarged** until a search algorithm will work.

Thus, the nature and size of the sub-regions of Applicants' invention are different from the nature and size of the windows of Nichani. Consequently, the second element of Applicants' invention as set forth in claim 1 has been shown to be absent from the teaching of Nichani.

Further, since the third element of claim 1 requires "sub-regions", and since Nichani is silent on sub-regions as taught by Applicants, then the third element of Applicant's invention as set forth in claim 1 has been shown to be absent from the teaching of Nichani.

Regarding the fourth element, claim 1 has been amended to make it more clear that "a <u>single</u> search tree" is built "for determining an order for inspecting <u>each sub-region of</u> the plurality of sub-regions at run-time". By contrast, Nichani teaches a plurality of trees that is also referred to by Nichani as a "forest" of trees. More particularly, Nichani teaches a "minimum spanning forest" (MSF) of minimum spanning trees (MST). At col. 9, lines 23-27, it is stated that "each box that is associated with a local alignment point ... is a starting vertex or root for a MST in the MSF." Also, at col. 10, lines 15-17, "each local alignment point encountered is associated with a box that then becomes the root of a respective tree." By contrast, Applicants' invention employs a **single** tree for **all** of the sub-regions, **not** a plurality of trees, i.e., not a "forest" of trees.

In addition, since the fourth element of claim 1 requires "sub-regions", and since Nichani is silent on sub-regions as taught by Applicants, then the fourth

element of Applicant's invention as set forth in claim 1 has been shown to be absent from the teaching of Nichani.

Regarding the fifth element of claim 1, Nichani teaches training a **plurality** of models for coarse alignment at col. 7, lines 16-17. Also at col. 7, lines 38-40, Nichani states that "the windows stored at train time provide respective limited areas of search for each of the coarse alignment patterns." By contrast, amended claim 1 requires "training a coarse alignment tool for the region of interest in its entirety." Consequently, the fifth element of Applicants' invention as set forth in claim 1 has been shown to be absent from the teaching of Nichani.

Thus, since **four** of the elements of Applicants' claim 1 are not taught by Nichani, as demonstrated above, the rejection of claim 1 under 35 USC 102(b) is deemed to be overcome.

Regarding claim 3, Nichani teaches that "at every step when the tree is constructed, each box is attached to a box closest to it in order to **minimize the sum of the distances between the boxes**" (col. 10, lines 53-55). By contrast, Applicants' claim 3 requires that the building of the search tree establish the order so that transformation information for located ones of the sub-regions is used **to minimize a search range** for neighboring ones of the sub-regions. Since it is possible to "minimize the sum of the distances between the boxes", and NOT minimize a search range, and vice-versa, these requirements are not equivalent.

In addition, claim 3 refers to sub-regions, which have been established to be absent from Nichani.

Further, claim 3 depends from a claim deemed to be allowable, and is therefore itself allowable as well.

Accordingly, the rejection of claim 3 under 35 USC 102(b) is deemed to be overcome.

Regarding claim 4, claim 4 refers to sub-regions, which have been established to be absent from Nichani.

Further, claim 4 depends from a claim deemed to be allowable, and is therefore itself allowable as well.

Accordingly, the rejection of claim 4 under 35 USC 102(b) is deemed to be overcome.

Regarding claim 6, it has been amended so as to include "inspecting each of the sub-regions so as to produce a difference image for each of the sub-regions. This is to further distinguish claim 6 from the teaching of Nichani, who does not teach producing a difference image for inspection purposes. Referring to col. 13, lines 45-57, it's now clear that Nichani instead teaches three parameters for inspection purposes: average grey level value, number of edges inside the box, and a shape score. By contrast, Applicants teach at least producing a difference image for each of the sub-regions, now made explicit in amended claim 6.

In addition, two out of three elements of claim 6 refers to sub-regions, which have been established above as being absent from Nichani. Accordingly, the rejection of claim 6 under 35 USC 102(b) is deemed to be overcome.

Regarding claim 14, it has been amended to make it more clear that the region divider divides the digitized image of a region of interest in its entirety into a plurality of sub-regions. Further, it has been amended to make it more clear that the search mechanism locates each of the sub-regions sequentially in an order based on a single search tree. Given these amendments, and the arguments presented above based upon these distinctions from Nichani, claim 14 can now be seen to have at least three elements that are **not** taught by Nichani. Accordingly, the rejection of claim 14 under 35 USC 102(b) is deemed to be overcome.

Claim 21 has been amended in a manner consistent with the amendments of claims 1 and 14, and is deemed to be allowable for analogous reasons. Accordingly, the rejection of claim 21 under 35 USC 102(b) is deemed to be overcome.

Claim 25 is analogous to claim 3, and is therefore deemed to be allowable for analogous reasons.

Accordingly the rejection of claims 1, 3, 4, 6, 14, 21, and 25 under 35 USC 102(b) as being anticipated by Nichani is deemed to be overcome.

Claims 27 and 28 have been rejected under 35 USC 103(a) as being unpatentable over Nichani (5,673,334). Regarding claim 27, it has been amended in analogy to claim 1, and therefore the arguments that were presented to overcome the rejection of amended claim 1 apply here as well. In particular, Nichani does not teach, suggest, or motivate "sub-regions" that cover an **entire** region of interest, as defined and claimed by Applicant, nor does Nichani teach, suggest, or motivate the use of a **single** tree. In fact, Nichani teaches away from "sub-regions" that cover an **entire** region of interest, and Nichani teaches away from the use of a **single** tree.

Regarding claim 28, since it is analogous to claim 3, the arguments in favor of claim 3 apply. Nichani teaches that "at every step when the tree is constructed, each box is attached to a box closest to it in order to **minimize the sum of the distances between the boxes**" (col. 10, lines 53-55). By contrast, Applicants' claim 28 requires that the building of the search tree "establish the order so that transformation information for located ones of the sub-regions is used **to minimize a search range** for neighboring ones of the sub-regions." Since it is possible to "minimize the sum of the distances between the boxes", and NOT minimize a search range, and vice-versa, these requirements are not equivalent.

In addition, claim 28 refers to sub-regions, which have been established to be absent from Nichani. In fact, Nichani teaches away from the "sub-regions" of Applicants. Further, claim 28 depends from a claim deemed to be allowable, and

is therefore itself allowable as well. Accordingly, the rejection of claims 27 and

28 under 35 USC 103(a) as being unpatentable over Nichani (5,673,334) is

deemed to be overcome.

Claims 2, 10, 17, 24 were rejected under 35 USC 103(a) as being

unpatentable over Nichani in view of Cipolla et al. Each of these claims refers to

"the size of the sub-regions" being "small enough such that each of the sub-

regions is well approximated by an affine transformation". Although Cipolla does

mention an "affine transformation", Cipolla actually teaches away from combining

affine transformation with Applicants' invention at col. 8, lines 12-20. Applicants'

specification on page 2, lines 3-5, teaches that "a nonlinear spatially distorted

image comprises a spatially mapped pattern that cannot be described as an

affine transform of an undistorted representation of the same pattern." By

contrast, Cipolla states at col. 8, lines 12-20 that "when ... the surface of the

object imaged by the observer is also **sufficiently smooth**, the velocity field

expressed by the above set of equations can be approximated by the linear

equations within each small image region." By contrast, Applicants teach and

claim that "the **size** of each of the sub-regions must be "small enough such that

each of the sub-regions is well approximated by an affine transformation". Note

that the claim language is silent on any characterization of the surface.

Further, Cipolla does not remedy the deficiencies of Nichani, so combining

Cipolla with Nichani would not result in Applicants' invention. For example,

Cipola does not teach "building a single search tree", and does not teach

"dividing the region of interest in its entirety into a plurality of sub-regions", both being required by claim 1, from which claim 2 depends. Accordingly, the rejection of claim 2 under 35 USC 103(a) is deemed to be overcome.

Moreover, since claims 10, 17, 24 depend from analogous independent claims, analogous arguments apply, such that the rejections of claims 10, 17, 24 under 35 USC 103(a) are also deemed to be overcome for analogous reasons.

Claims 5, 13, and 20 were rejected under 35 USC 103(a) as being unpatentable over Nichani in view of Aiyer. Each of these claims calls for "using a golden template comparison method".

Aiyer does not remedy the deficiencies of Nichani, so <u>combining Aiyer with Nichani would not result in Applicants' invention</u>. For example, neither Nichani nor Aiyer teaches "building a single search tree", and neither Nichani nor Aiyer teaches "dividing the region of interest in its entirety into a plurality of sub-regions", both being required by claim 1, from which claim 5 depends. Accordingly, the rejection of claim 5 under 35 USC 103(a) is deemed to be overcome.

Moreover, since claims 13 and 20 depend from analogous independent claims, analogous arguments apply, such that the rejections of claims 13 and 20 under 35 USC 103(a) are also deemed to be overcome for analogous reasons.

Claims 11, 18, 26, and 32 were rejected under 35 USC 103(a) as being unpatentable over Nichani in view of Miyaki.   Each of these claims calls for "using transformation information from located ones of the sub-regions to interpolate transformation information for a sub-region when the sub-region cannot be located". Here, note that "transformation information" refers to **location** information as represented by a "pose", or position transformation, as is well-known in the art of machine vision. See specification, page 5, lines 7-9, for example.

By contrast, Miyaki teaches transformation of **pixel value** information. Fig. 6 of Miyaki shows how pixel information is transformed within a window, giving starting and transformed values in windows 601 and 602, respectively. Thus, Miyaki does not teach "transformation" as taught by Applicatants. Consequently, for this reason alone, combining Miyaki with Nichani would not result in Applicants' invention.

Further, Miyaki does not remedy the deficiencies of Nichani, so <u>combining Miyaki with Nichani could not possibly result in Applicants' invention</u>. For example, neither Nichani nor Miyaki teaches "building a single search tree", and neither Nichani nor Miyaki teaches "dividing the region of interest in its entirety into a plurality of sub-regions", both being required by claim 1, from which claim 11 depends. Accordingly, the rejection of claim 11 under 35 USC 103(a) is deemed to be overcome.

Moreover, since claims 18, 26, and 32 depend from analogous independent claims, analogous arguments apply, such that the rejections of claims 18, 26, and 32 USC 103(a) are also deemed to be overcome for analogous reasons.

Claim 33 was rejected under 35 USC 103(a) as being unpatentable over Nichani in view of Clark. Clark does not teach what is claimed in amended claim 33. Clark teaches inspecting each block "to determine whether the data elements for that block may be **represented in a highly compact format**". (see Abstract, lines 3-5) By contrast, Applicants' amended claim 3 requires: "dividing one of the sub-regions into a plurality of smaller sub-regions when the one of the sub-regions cannot be **located using a search tool**." Thus, the methods and goals of Clark and Nichani are very different. In fact, there is nothing that teaches, suggests, or motivates combining Clark with Nichani. Further, even if one did combine these references, the result would not be Applicants invention as claimed in claim 33. Accordingly, the rejection of claim 33 under 35 USC 103(a) is deemed to be overcome.

Claims 12 and 19 were rejected under 35 USC 103(a) as being unpatentable over Nichani in view of Dance. The Examiner asserts that Dance teaches predicting registration results. However, claim 12 requires "predicting registration results ... when training of the search tool ... was not successfully performed". Dance clearly does not teach the condition "when training of the

search tool ... was not successfully performed". Dance does teach predicting

registration results as part of a "coarse-to-fine" strategy for alignment, as stated

in col. 9, lines 65-67. Thus, Dance teaches away from predicting registration

results "when training of the search tool ... was not successfully performed", as

required by claim 12.

Further, since neither Dance nor Nichani teaches the condition "when

training of the search tool ... was not successfully performed", combining these

references would not result in Applicants' invention. Consequently, the rejection

of claim 12 under 35 USC 103(a) is deemed to be overcome.

Regarding claim 19, analogous arguments are applicable. Consequently,

the rejection of claim 9 under 35 USC 103(a) is deemed to be overcome.

Claim 29 has been rejected under 35 USC 103(a) as being unpatentable

in view of Barnard. Claim 29 depends from claim 27, which has been deemed

patentable over Nichani, as explained above. Barnard does not repair the

deficiencies of Nichani, so combining Barnard and Nichani would not result in

Applicants' invention as set forth in claim 27.

Moreover, Nichani teaches away from using a difference image and a

match image, as required by claim 29. In the application discussed in Nichani, a

check mark must be detected within boxes on a film package. It is the presence

or absence of a check mark that must be detected (col. 13, lines 45-47). One of

average skill in the art would immediately recognize that using a template

matching approach to create a match image and a difference image would not be practical, due to the wide variety of check marks that could be drawn by a human hand marking within a box. Thus, nothing in Nichani teaches, suggests, or motivates the creation of a difference image, or a match image, since template matching would not be used in Nichani. Consequently, the rejection of claim 29 under 35 USC 103(a) is deemed to be overcome.

Claims 8, 16, 23, and 30 have been rejected under 35 USC 103(a) as being unpatentable over Nichani, in view of Companion, in further view of Barnard. Claim 8 depends from claim 6, which has been deemed patentable over Nichani, as explained above. Companion and Barnard taken together do not repair the deficiencies of Nichani, so combining Companion, Barnard and Nichani would not result in Applicants' invention as set forth in claim 8.

Moreover, Nichani teaches away from using a difference image and a match image, as required by claim 8. In the application discussed in Nichani, a check mark must be detected within boxes on a film package. It is the presence or absence of a check mark that must be detected (col. 13, lines 45-47). One of average skill in the art would immediately recognize that using a template matching approach to create a match image and a difference image would not be practical, due to the wide variety of check marks that could be drawn by a human hand marking within a box. Thus, nothing in Nichani teaches, suggests, or motivates the creation of a difference image, or a match image, since template matching would not be used in Nichani.

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Given that Nichani does not teach, suggest, or motivate the creation of a difference image for sub-regions, there is even less teaching, suggestion, or motivation to **combine** difference images of sub-regions. Consequently, the rejection of claim 8 under 35 USC 103(a) is deemed to be overcome.

Regarding the rejection of claims 16, 23, and 30, analogous arguments are applicable. Consequently, the rejection of claims 16, 23, and 30 under 35 USC 103(a) is deemed to be overcome.

Claims 7, 15, 22, and 34-36 have been rejected under 35 USC 103(a) as being unpatentable over Nichani, in view of Michael, in further view of Murata. Regarding claim 7, there is no teaching, suggestion, or motivation to combine any two of these references, and one of average skill in the art of machine vision would be taught away from combining all three. That's because Michael teaches an article of manufacture for removing distortion prior to location of features on a semiconductor wafer (Abstract, lines 1-5). The distortion itself is not used for inspection purposes ... in Michael, distortion must be **removed** prior to inspection. Motion or movement is never discussed in Michael or Nichani.

Further, in Michael, distortion is due to optical effects, not features of the object under inspection or measurement. For example, Michael discusses distortion due to lens irregularities, tilt of the lens, and tilt of the camera. Col. 7, lines 30-37. Michael also mentions perspective distortion, scale factors, and chromatic distortion. Col. 7, lines 37-45. By contrast, Applicants' are silent on

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optical distortion, instead using "distortions" of a pattern as compared with a model pattern (see specification, page 5, lines 17-18). Such distortions are wells-suited for inspection purposes, since the distortions are due to the object under inspection. Distortions in Michael are not useful for inspection purposes, because they are due to the optical system used to view and inspect the object, and consequently, are not indicative of the object itself.

In Murata, detection of movement is the issue, NOT inspection or correction of optical distortion. Murata teaches a plurality of motion vectors, and summing values related to the motion vectors. The sum of the values relating to the motion vectors is compared with a stored value to determine whether a change between scenes has occurred (col. 28, lines 19-54). This NOT a "pass/fail decision". Thus, Murata is not related to Michael, because Michael is silent on detecting movement, and Murata is silent on correcting distortion. Further, Murata is not related to Nichani, because Nichani is silent on movement, and Murata is silent on inspection, i.e., Murata is silent on making a "pass/fail decision". Thus, there is no motivation whatsoever to combine these three references to obtain Applicants' invention, and any motivation to combine all three is entirely absent.

Further, even if one were to combine these three references, the result would not be Applicants' invention, because neither Michael nor Murata repairs the deficiencies of Nichani, as set forth above in discussions of claims 1, 6, 14, 21, and 27, for example.

Consequently, the rejection of claim 7 under 35 USC 103(a) is deemed to be overcome.

Regarding the rejection of claims 15, 22, and 34-36, analogous arguments are applicable. Consequently, the rejection of claims 15, 22, and 34-36 under 35 USC 103(a) is deemed to be overcome.

Claim 31 has been rejected under 35 USC 103(a) as being unpatentable over Nichani in view of Michael, in further view of Murata and Barnard. As explained in the traverse of the rejection of claim 7, there is no teaching, suggestion, or motivation to combine these references, including Barnard. Moreover, these references teach away from such a combination. Even if one were to combine them, the result would not be Applicants' invention. Further, it's not clear that such a combination would be functional. Consequently, the rejection of claim 31 under 35 USC 103(a) is deemed to be overcome.

Claim 9 has been rejected under 35 USC 103(a) as being unpatentable over Nichani in view of Michael, in further view of Murata, Companion, and Barnard. As explained in the traverse of the rejection of claims 7 and 8, there is no teaching, suggestion, or motivation to combine these references, including Companion and Barnard. Moreover, these references teach away from such a combination. Even if one were to combine them, the result would not be Applicants' invention. Further, it's not clear that such a combination would be

functional. Also, Michael, Murata, Companion and Barnard fail to remedy the deficiencies of Nichani. Consequently, the rejection of claim 9 under 35 USC 103(a) is deemed to be overcome.
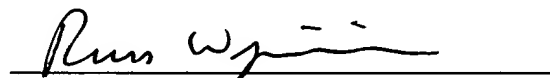
The prior art made of record and not relied upon does not appear to present an impediment to the patentablity of the claims as amended.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "**VERSION WITH MARKINGS TO SHOW CHANGES MADE**".

Accordingly, Applicants assert that the present application is in condition for allowance, and such action is respectfully requested. The Examiner is invited to phone the undersigned attorney to further the prosecution of the present application.

Respectfully Submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The paragraph beginning at page 3, line 7, has been amended as follows:

-- [FIG.] Fig. 1 is a diagram which shows components of a machine vision system;--

The paragraph beginning at page 4, line 7, has been amended as follows:

-- Image processing system 100 includes storage 6 for receiving and storing the digital image. The storage 6 could be, for example, a computer memory.--

The paragraph beginning at page 5, line 24, has been amended as follows:

-- At [p202] P202 a region of interest within the digitized image is divided into a plurality of sub-regions. Fig. 3, for example, shows region of interest 300 being divided into 9 sub-regions(1-9) in a form of a 3x3 array. However, the region of interest could be divided into any number of sub-regions. --

In the claims:

Claims 1, 6, 8, 14, 21, 27 have been amended as follows:

1. (Amended) A method for training a system to inspect a spatially distorted pattern, the method comprising:

receiving a digitized image of an object, the digitized image including a region of interest;

dividing the region of interest in its entirety into a plurality of sub-regions, a size of each of the sub-regions being small enough such that a conventional inspecting method can reliably inspect each of the sub-regions;

training a search tool and an inspection tool for a respective model for each of the plurality of sub-regions;

building a single search tree for determining an order for inspecting each sub-region of the plurality of sub-regions at a run-time; and

training a coarse alignment tool for the region of interest in its entirety.

6. (Amended) A method for inspecting a spatially distorted pattern, the method comprising:

running a coarse alignment tool to approximately locate the pattern;

using search tree information and an approximate location of a root sub-region, found by the coarse alignment tool, to locate a plurality of sub-regions sequentially in an order according to the search tree information, each of the sub-regions being of a size small enough such that a conventional inspecting method can reliably inspect each of the sub-regions using respective models; [and]

inspecting each of the sub-regions so as to produce a difference image for each of the sub-regions.

8. (Amended) The method of claim 6, wherein:

the inspecting produces [a difference image for each of the sub-regions and] a match image for each of the sub-regions, the method further comprising:

combining the difference images for each of the sub-regions into a single difference image; and

combining the match images for each of the sub-regions into a single match image.

14. (Amended) An apparatus for inspecting a spatially distorted pattern, the apparatus comprising:

a memory for storing a digitized image of an object;

a region divider for dividing the digitized image [image] of a region of interest in its entirety into a plurality of sub-regions, a size of each of the sub-regions being small enough such that a conventional inspecting method can reliably inspect each of the sub-regions;

a coarse alignment mechanism for approximately locating the pattern;

a search mechanism for locating each of the sub-regions sequentially in an order based on a single search tree [information]; and

an inspector for inspecting each of the sub-regions.

21. (Amended) An apparatus for inspecting a spatially distorted pattern, the apparatus comprising:

a storage for storing a digitized image of an object, the digitized image including a region of interest;

a region divider for dividing the region of interest in its entirety into a plurality of sub-regions, a size of each of the sub-regions being small enough such that a conventional inspecting method can reliably inspect each of the sub-regions;

a trainer for training a respective model for a search tool and for an inspection tool for each of the plurality of sub-regions;

a search tree builder for building a single search tree for determining an order for inspecting each sub-region of the plurality of sub-regions at a run time;

a course alignment trainer;

a course alignment mechanism for approximately locating the pattern, the coarse alignment mechanism being configured to be trained by the coarse alignment trainer;

a search mechanism for locating each of the sub-regions sequentially in an order based on the search tree, a root sub-region being provided by the coarse alignment mechanism; and

an inspector for inspecting each of the sub-regions.

27. (Amended) A medium having a stored therein machine-readable information, such that when the machine-readable information is read into a memory of a computer and executed, the machine-readable information causes the computer:

to receive a digitized image of an object, the digitized image including a region of interest;

to divide the region of interest in its entirety into a plurality of sub-regions, a size of each of the sub-regions being small enough such that a conventional inspecting method can reliably inspect each of the sub-regions;

to train a respective model for a search tool and for an inspection tool for each of the plurality of sub-regions;

to build a single search tree for determining an order for inspecting the plurality of sub-regions at a run-time; and

to train a respective model for a coarse alignment tool.

33. (Amended) The method of claim 6, further comprising:

dividing one of the sub-regions into a plurality of smaller sub-regions when the one of the sub-regions cannot be located [during the using of the search tree information to locate the plurality of sub-regions] using a search tool.